WE CLAIM:

1. An optical device, comprising:

   a first waveguide;

   a second waveguide; and

   a birefringent optical system with bi-directional, polarization-dependent free-space paths, one of the bidirectional, polarization-dependent, free-space paths coupling at least the first waveguide to the second waveguide, the birefringent optical system including at least one prism for bending one of the polarization-dependent paths in a clockwise direction and one of the polarization-dependent paths in a counterclockwise direction.

2. The optical device as recited Claim 1, wherein the birefringent optical system includes a first converging optical subsystem for coupling at least the first waveguide to light propagating along the free-space paths and a second converging optical subsystem for coupling the second waveguide to light propagating along at least one of the free-space paths.

3. The optical device as recited in Claim 2, wherein at least one of the converging optical subsystems includes a lens.

4. The optical device as recited in Claim 1, wherein light propagating in the second waveguide is polarized.

5. The optical device as recited in Claim 1, wherein the light propagates through the birefringent optical system from the first waveguide to the second waveguide.

6. The optical device as recited in Claim 1, wherein the light propagates through the birefringent optical system from the second waveguide to the first waveguide.

7. The optical device as recited in Claim 1, wherein the prism is formed from a birefringent material.

8. The optical device as recited in Claim 1, wherein the birefringent optical system includes a birefringent splitter, light propagating along the free-space paths interacting with the material.

9. The optical device as recited in Claim 8, wherein the prism is attached to the birefringent material.

10. The optical device as recited in Claim 8, wherein the prism is integrated with the birefringent splitter.

11. The optical device as recited in Claim 2 additionally comprising a third waveguide, the second converging optical subsystem coupling the second waveguide to the polarization dependent path bent in a clockwise direction and third waveguide to the polarization dependent path bent in a counterclockwise direction. .

12. The optical device as recited in Claim 11, wherein the prism has a symmetry axis and the polarization dependent paths intersect a plane containing the symmetry axis in a crossover region between the prism and the second and the third waveguides.

13. The optical device as recited in Claim 12 wherein the first converging optical subsystem and the second converging optical subsystem have a common

focal distance, f, and the second optical subsystem is separated by approximately the common focal distance, f, from the crossover region, the first waveguide is separated from the first converging optical subsystem by the common focal distance, f, and the second converging optical subsystem is separated from the second waveguide by approximately the common focal distance, f.

14. An optical device, comprising:

a first waveguide;

at least a second waveguide; and

a folded optical system with bi-directional, polarization-dependent free-space paths that couple the first waveguide and the at least a second waveguide, the optical system including a birefringent path separator that is traversed by light propagating along the free-space paths in a first direction and in a second direction approximately opposite to the first direction.

15. The optical device as recited in Claim 14, wherein light propagating in the second waveguide is polarized.

16. The optical device as recited in Claim 14, wherein the light propagates through the folded optical system from the first waveguide to the second waveguide

17. The optical device as recited in Claim 14 wherein the light propagates through the folded optical system from the second waveguide to the first waveguide.

18. The optical device as recited in Claim 14, wherein the folded optical system includes an optical subsystem that couples light propagating along the free-space paths to the first waveguide and the second waveguide.

19. The optical device as recited in Claim 18, wherein the optical subsystem is a coupling module.

20. The optical device as recited in Claim 14, wherein the birefringent beam separator is formed from a crystal.

21. The optical device as recited in Claim 14, wherein the folded optical system includes a polarization rotator and a mirror, the mirror disposed to direct light propagating in a first direction to a second, reverse direction and the polarization rotator disposed to interact with the light propagating along the free-space paths in both the first and second directions, rotating polarization of the light propagating in the second direction by approximately 90° relative to the light propagating in the first direction.

22. The optical device as recited in Claim 21, wherein the mirror is formed on the polarization rotator.

23. The optical device as recited in Claim 21, wherein the polarization rotator is attached to the birefringent path separator.

24. The optical device as recited in Claim 14, wherein the folded optical system includes a faceted reflector and a symmetry axis intersecting the birefringent beam separator and the faceted reflector, the symmetry axis being approximately parallel and equidistant from the light propagating in the first

direction and the light propagating in the second direction along at least one of the free space paths.

25. An optical device, comprising:

a first waveguide;

a second waveguide coupled to the first waveguide via a first bi-directional, polarization dependent path;

a third waveguide coupled to the first waveguide via a second bi-directional, polarization dependent path;

a Wollaston prism disposed on the first and second bi-directional, polarization dependent paths, the first and second bi-directional, polarization dependent paths overlapping between the first waveguide and the Wollaston prism; and

a first converging optical subsystem disposed to couple light between the second waveguide and the Wollaston prism and between the third waveguide and the Wollaston prism, the first converging optical subsystem including at least one focusing element common to the first and the second bi-directional, polarization dependent paths.

26. The optical device as recited in Claim 25, wherein the first converging optical subsystem includes a lens.

27. The optical device as recited in Claim 25, further comprising a second converging optical subsystem coupling light between the first waveguide and the Wollaston prism.

28. The optical device as recited in Claim 27, wherein the first and second converging optical subsystems have a common focal distance, f, and the first waveguide is separated by approximately the focal distance, f, from the

second optical subsystem, the first optical subsystem is separated approximately the focal distance, f, from the Wollaston prism, and the first optical subsystem is separated approximately the focal distance, f, from at least the second waveguide.

29. The optical device as recited in Claim 25 wherein light propagating in the second waveguide is polarized.

30. The optical device as recited in Claim 25, wherein light propagates along the first bi-directional, polarization dependent path from the first waveguide to the second waveguide.

31. The optical device as recited in Claim 25, wherein propagates along the first bi-directional, polarization dependent path from the second waveguide to the first waveguide.

32. The optical device as recited in Claim 25, wherein the Wollaston prism is formed from a crystalline material selected from the group of yttrium ortho-vanadate (YVO_4), lithium niobate ($LiNbO_3$), α-BBO (BaB_2O_4), TeO_2, and rutile (TiO_2).

33. An optical device, comprising:

a first waveguide;

a second waveguide;

a third waveguide;

a converging optical system; and

a birefringent optical system defining a first polarized optical path between the first waveguide and the second waveguide and defining a second polarized optical path between the first waveguide and the third

waveguide, polarization of light propagating along the first polarized optical path being orthogonally polarized to polarization of light propagating along the second polarized optical path, the converging optical system including at least one focusing element disposed on both the first and second polarized optical paths where the first polarized optical path is spatially separated from the second polarized optical path.

34. The optical device as recited in Claim 33 wherein the first and the second polarized optical paths pass through a second converging optical system where the first and second polarized optical paths are spatially coincident, the second converging optical system coupling the light propagating along the first path and the light propagating along the second path to the first waveguide.

35. The optical device as recited in Claim 33, wherein the light propagating along the first polarized optical path propagates from the first waveguide to the second waveguide.

36. The optical device as recited in Claim 33, wherein the light propagating along the second polarized optical path propagates from the first waveguide to the third waveguide.

37. The optical device as recited in Claim 33, wherein the light propagating along the first polarized optical path propagates from the second waveguide to the first waveguide.

38. The optical device as recited in Claim 33, wherein the light propagating along the second polarized optical path propagates from the third waveguide to the first waveguide.

39. The optical device as recited in Claim 33, wherein the birefringent optical system includes a Wollaston prism that bends the first polarized optical path and the second polarized optical path in different directions.

40. The optical device as recited in Claim 33, wherein the birefringent optical system includes a birefringent material that separates the first and second polarized optical paths.

41. The optical device as recited in Claim 40, wherein the birefringent optical system includes a prism that bends the first polarized optical path in a clockwise direction and the second polarized optical path in a counterclockwise direction.

42. The optical device as recited in Claim 40, wherein light propagating along the first and second polarized optical paths traverses the birefringent material in a first direction and in a second, approximately opposite direction.

43. The optical device as recited in Claim 42, wherein the birefringent optical system includes a mirror and a polarization rotator, the mirror reflecting light propagating in the first direction into the second direction, and the polarization rotator rotating polarization of the light propagating in the first direction and the light propagating in the second direction so that polarization of the light propagating in the second direction is rotated by approximately 90° relative to polarization of light propagating in the first direction.

44. The optical device as recited in Claim 42, the birefringent optical system including a faceted reflector that redirects the light from the first direction to

the second direction and inverts spatial position of the light propagating in first direction and the light propagating in the second direction along at least one path with respect to an axis of symmetry.

45. An optical communications system, comprising:

a transmitting unit;

a receiving unit; and

an optical transport system coupled to carry optical information signals between the transmitting unit and the receiving unit, at least one of the transmitting unit, the receiving unit, and the optical transport system including an optical device for coupling a first light beam to a second polarized light beam and a first beam to an orthogonally polarized light beam, the optical device including

i) a first waveguide,

ii) a second waveguide, and

iii) a birefringent optical system with bi-directional, polarization-dependent free-space paths, one of which couples at least the first waveguide to the second waveguide, the birefringent optical system including at least one prism for bending one of the polarization-dependent paths in a clockwise direction and bending one of the polarization-dependent paths in a counterclockwise direction.

46. An optical communications system, comprising:

a transmitting unit;

a receiving unit; and

an optical transport system coupled to carry optical information signals between the transmitting unit and the receiving unit; at least one of the transmitting unit, the receiving unit, and the optical transport including an optical device for coupling a first light beam to a second polarized light

beam, the optical device including

i) a first waveguide,

ii) a second waveguide, and

iii) a folded optical system with bi-directional, polarization-dependent free-space paths that couple the first waveguide and at least the second waveguide, the folded optical system including a birefringent path separator that is traversed by light propagating along the free-space paths in a first direction and second, approximately opposite direction.

47. An optical communications system, comprising:

a transmitting unit;

a receiving unit; and

an optical transport system coupled to carry optical information signals between the transmitting unit and the receiving unit; at least one of the transmitting unit, the receiving unit, and the optical transport including an optical device for coupling a first light beam to a second polarized light beam, the optical device including:

i) a first waveguide,

ii) a second waveguide coupled to the first waveguide via a first bi-directional, polarization dependent path,

iii) a third waveguide coupled to the first waveguide via a second bi-directional, polarization dependent path,

iv) a Wollaston prism disposed on the first and second bi-directional, polarization dependent paths, the first and second bi-directional, polarization dependent paths overlapping between the first waveguide and the Wollaston prism, and

v) a first converging optical subsystem disposed to couple light between the second waveguide and the Wollaston prism and between the third waveguide and the Wollaston prism, the first converging optical

subsystem including at least one focusing element common to the first and the second bi-directional, polarization dependent paths.

48. A method of coupling light propagating in a first waveguide to polarized light propagating in at least a second waveguide, the method comprising:

propagating the light along first and second bi-directional, polarization-dependent free-space paths, polarization of light propagating along the first bi-directional, polarization-dependent free-space path being orthogonal to polarization of light propagating along the second bi-directional, polarization-dependent free-space path; and

bending the first polarization-dependent path in a counterclockwise direction and the second polarization-dependent path in a clockwise direction with a prism.

49. The method recited in Claim 47, including focusing the polarized light travelling along the first and the second free space paths with a converging optical system that includes at least one focusing element common to the first and second paths in a region where the first and second paths are spatially separated.

50. The method recited in Claim 47, including directing the light propagating along the bidirectional free-space path from the first waveguide to the second waveguide.

51. The method recited in Claim 47, including directing the light propagating along the bidirectional free-space path from the second waveguide to the first waveguide.

52. A method of coupling light in a first waveguide to at least a second waveguide, comprising:

propagating the light along bi-directional, polarization-dependent free-space paths including a first path for propagating polarized light and a second path for propagating light polarized orthogonally to polarization of light propagating along the first path; and

traversing the light through a birefringent path separator in a first direction and in a second, approximately opposite direction.

53. The method of Claim 52, including reflecting the light propagating in the first direction along the polarization-dependent free-space paths in a second approximately opposite direction with a mirror and rotating polarization of the light propagating along the free space paths in the first and the second directions with a polarization rotator.

54. The method of Claim 52, including translating and redirecting the light propagating along the polarization-dependent paths in the first direction to the light propagating along the polarization-dependent paths in the second, approximately opposite direction with a faceted reflector.

55. The method of Claim 52, including coupling the light in the waveguides to the light propagating along the polarization-dependent paths with a coupling module.

56. A method of coupling light between a first waveguide and second and third waveguides, comprising:

propagating the light along bi-directional, polarization-dependent free-space paths including propagating polarized light along a first path between the first and second waveguides and propagating polarized light, polarized

orthogonally relative to light propagating along the first path, along a second path between the first and third waveguides; and

spatially separating and bending the first and second paths with a Wollaston prism.

57. The method recited in Claim 56, including focusing the polarized light travelling along the first and second paths where the first and second paths are spatially separated with a focusing element common to the first and second paths.

58. The method recited in Claim 56, including directing the light propagating along the polarization-dependent paths from the first waveguide to the at least a second waveguide.

59. The method recited in Claim 56 including directing the light propagating along the polarization-dependent paths from the at least a second waveguide to the first waveguide.

60. A method of coupling between a first waveguide and second and third waveguides, the method comprising:

interacting the light with a birefringent optical system along a first optical path between the first and second waveguides and a second optical path between the first and third waveguides, light propagating along the second path having a polarization orthogonal to a polarization of light propagating along the first path where the first and second paths are spatially separated; and

coupling the light between the birefringent optical system and the second and third waveguides with a converging optical subsystem having at

least one focusing optical element common to the first and second paths where the first and second paths are spatially separated.